Office for Applied Social Science and the Future

REPORT OF DELPHI INQUIRY INTO THE FUTURE OF AMERICAN WATER RESOURCE UTILIZATION AND DEVELOPMENT

University of Minnesota

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Richard G. Woods
Co-Director, Office for Applied
Social Science and the Future
University of Minnesota
Minneapolis, Minnesota

Harold S. Becker
Treasurer, The Futures Group
Glastonbury, Connecticut

George Patrick Johnson
Institute for Water Resources
Alexandria, Virginia

Office for Applied Social Science and the Future
University of Minnesota
Minneapolis, Minnesota

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Introduction and Background

This report deals with the results of a Delphi exercise which involved panelists from across the United States and whidh focussed upon the future of water resource utilization and development and related socio-cultural influences. The experiment occurred between January and October of 1972, and it involved circulation of three separate inquiries about problems and events during the next thirty years among panelists drawn from a rather wide spectrum of those concerned with American water resources.

Participants were asked to estimate the likely future direction of value change in America; they were asked to respond to a set of seven future water resource problems and their related possible events and alternative actions; they were asked to submit additional future water resource problems, events and actions; and, finally, they were asked to make some judgments about the entire group of problems, events and actions and to relate the actions to the future value configuration they had previously indicated. On August 17, 18, and 19 a symposium based upon the Delphi exercise was held in Arlington, Virginia; selected participants in the experiment as well as some non-participants were invited to address future water resource problems from a socio-cultural perspective.

The organizations which cooperated in the execution of the Delphi exercise and the symposium were the Institute for Water Resources, U.S. Army Corps of Engineers (the funding agency), the Futures Group, and the Office for Applied Social Science and the Future, University of Minnesota. The latter organization held principal responsibility.

Choice of the Delphi

In this effort, it was decided to employ the Delphi technique, which provides a mechanism for a "cool" debate among previously-identified experts by means of anonymously polling them and feeding back their responses to stimulate further exploration and assessment by each panelist. This technique has the advantage of eliminating the disporportionate influence enjoyed in face-to-face conferences by dominant personalities and authorities of great repute, and it is one practicable way of "connecting" experts who are widely separated by distance and unable to meet for debate and discussion because of travel and time constraints. It has the disadvantages of slowness and less flexibility and opportunity for clarification when compared to free discussion, and it may be rather costly when the referee closely follows

up the written comments of panelists to achieve maxiumu clarity.

The Delphi method was selected because it was believed that it would provide a rather broadly-based input of expert opinion and because it might prove to be a useful addition to the planning process. It was understood at the outset by the cooperating agencies that experts are fallible and cannot truly "predict" the future in all its complexity, but it was felt that identification of possible or probable future trends, problems, and influences by those who are close to water resources would contribute a body of information to be used in conjunction with more conventional planning bases.

Composition of the Panel

The cooperating agencies decided to define "expert" broadly enough to involve as panel members persons whose occupations and activities seemed likely to influence the future development and utilization of water resources as well as those more conventionally acknowledged to be specialists in the field. An initial list of potential panelists was drawn up using information sources known to the three cooperating agencies and letters of invitation were sent to these persons. A reply postcard was enclosed, asking for the addressee's decision about participation and also asking him to recommend other appropriate panelists. New invitations were extended, in particular to those persons who were repeatedly suggested as panelists by those receiving the first invitation.

Using this procedure, more than 280 invitations to participate were sent. There were 124 acceptances. Fifty-nine persons specifically declined, and those who gave reasons for declining indicated they would not participate because they did not think they were qualified, because they had insufficient time, because they were ill, or because they planned to be out of the country or otherwise inaccessible.

One hundred persons returned usable Round One inquiries. From self-descriptions solicited on Round One, it was possible to group these respondents into seven categories, which were defined as follows:

- General Academics, who were college and university professors demonstrating interests and activities far broader than water resources alone.
- Water Resources Academics, who were college and university professors focussing rather specifically upon problems associated with water resources.

-General Government Representatives, who were federal government employees in agencies having responsibilities much broader than water resources alone.

-Water Resources Government Representatives, who were government employees at federal, state, and local levels with responsibilities rather specifically related to water resources.

-Commercial Representatives, who were employees of firms and industrial or water transportation associations or who were independent entrepreneurs linked in some way to water resources.

-Private and Public Interest Group Representatives and Private Citizens, who were representatives or members of organizations concerned with water resources, including citizen activist groups and ecology organizations. This category also included some who considered themselves simply as informed and concerned private citizens.

-Consultants, who were persons noted for their expertise in matters associated directly or indirectly with water resources.

Three judges independently classified each of the one hundred Round One panelists into one of these seven respondent categories. The differences which occurred between these independent classifications were reconciled by the judges and it was possible to ascertain the distribution of respondents. That distribution, and the distributions for the subsequent Round Two and Round Three are described below:

Respondent Category	Round One	Round Two	Round Three
General Academics	21	16	11
Water Resources Academics	18	14	12
General Government Representatives	7	3	4
Water Resources Government Representatives	20	17	10
Commercial Representatives	10	5	4
Private and Public Interest Group Representatives and Private Citizens	14	13	7
Consultants	10	6	3
TOTALS	100	74	51

Any interpretation of panel attrition between Round One and Round Three should be made with some additional information. The panelists were not provided with any remuneration for their efforts, as is sometimes the case with Delphi exercises. Moreover, the amount of instructions and material to be assimilated and dealt with by panelists grew with each successive round in the process, and this resulted in a work load for

respondents which exceeded expectations. Finally, the three rounds were initiated in February, April, and June, respectively, so that the last round reached panelists during the vacation season.

Considering these factors, it seemed to the cooperating organizations that the extent of participation throughout the process was gratifying.

In addition to these rather general comments about background, instrument choice, and panel composition, later sections of this report will discuss in some detail methodological considerations at each stage of the investigation. At this point, we shall turn to substantive results.

Results: Perceptions of Future U.S. Values

Round One panelists were asked to provide estimates about likely changes during the next thirty years in each of the values listed in a register of American values. These values were grouped according to the setting appropriate to the maintenance of the values - that is, oneself, one's group, the society, the nation, all of mankind, and the environment. The Appendix to this report contains tables showing the proportions of the panel who estimated "probably less important than today", "probably about the same importance as today", and "probably more important than today" for each value.

The responses of the entire panel were scored and interpreted in a special way so that the extent and nature of group consensus could be judged. The tables on the following pages serve as a summary of these group estimates.

It is clear from these tables that the panel estimated more positive (23) than negative (14) value shifts for Americans in the next thirty years. No change in importance was estimated for eighteen values. In the case of the remaining seventeen values, no consensus appeared with respect to future change or stability. Taken in their entirety, these estimates reflect the panel's perceptions of the direction and nature of American value change before the turn of the century. In the panel's view, changes in self-oriented values will be rather mixed; there likely will be more stability than change in group-oriented values; there probably will be a positive shift in most society-oriented values; most nation-oriented values are apt to undergo erosion; mankind-oriented values for the most part will become more important; and one of the two environment-oriented values

will become much more important.

Self-Oriented Values

Significantly more important among self-oriented values are likely to be Health and Well-Informedness, while a significant lessening in importance is apt to occur for Self-Reliance.

It is likely, according to the panel, that Self-Fulfillment will be more important to Americans in the next thirty years, while Readiness for Hard Work and Toughness probably will become less important.

The panel estimated that Economic Security and Well-Being is somewhat likely to decline in importance as is Self-Advancement. Inventiveness and Innovativeness, Intellectual Skills, and Self-Respect are somewhat apt to grow in importance.

No change in importance was foreseen by the panel for Physical Virtues, Initiative and Activism (as a strength of character), Perseverance and Stedfastness, and Initiative (as a skill).

In the case of six self-oriented values, the panel could not reach a first-round consensus: Personal Security, Personal Liberty, Self-Control, Competence, Faith, and Appreciation and Appreciativeness.

Group-Oriented Values

Devotion to Principle, according to the panel, is apt to significantly decline in importance by the turn of the century, while Personal Tolerance is apt to significantly increase.

Somewhat likely to become more important in the future are Fellow-feeling and Forthrightness; on the other hand, the panel thought that the Domestic Virtues are somewhat likely to decrease in importance.

No future change in importance was anticipated for: Rectitude and Personal Morality; Reasonableness and Rationality; Devotion to Family and Duty; Friendship Proper; Friendliness, Kindliness, Helpfulness, Cooperativeness, and Courteousness; Gregariousness; Receptivity; Generosity; Recognition; Forthrightness; Fair Play; and Loyalty.

The panel could reach no consensus about the future importance of Respectability, The Civic Virtues, Patience, Service, Idealism, and Personal Responsibility and Accountability.

Society-Oriented Values

The panel saw a significant increase in importance for Social Welfare as a value by the turn of the century.

SELF-ORIENTED VALUES

		TOTAL N	SCORE*	INDEX*	INTERPRETATION*
1-A	Health	99	53	+.54	+++
1-B	Economic Security and Well-Being	96	-28	-.29	-0
1-C	Personal Security	93	18	+.19	
2	Self-Respect	97	33	+.34	0+
3	Self-Reliance	99	-51	-.52	---
4	Personal Liberty	100	19	+.19	
5	Self-Advancement	98	-31	-.32	-0
6	Self-Fulfillment	100	49	+.49	00++
7-A	Intellectual Virtues	99	34	+.34	0+
7-B	Physical Virtues	99	- 7	-.07	00
7-C(1)	Readiness for Hard Work	97	-41	-.42	--00
7-C(2)	Toughness	95	-33	-.35	--00
7-C(3)	Initiative and Activism	95	-19	-.20	00
7-C(4)	Self-Control	97	+ 4	+.04	
7-C(5)	Perseverance and Stedfastness	98	-22	-.22	00
7-D	Competence	95	- 5	-.05	
7-E	Inventiveness and Innovativeness	97	+26	+.27	0+
7-F	Initiative	99	-14	-.14	00
7-G	Well-Informedness	100	+53	+.53	+++
7-H	Faith	100	+14	+.14	
7-I	Appreciation and Appreciativeness	97	+23	+.24	

*The key to the score, index and interpretation for the above values and those on following pages is as follows:

1. For the score, count

"probably less" = -1
"probably same" = 0
"probably more" = +1

2. The change index is the mean score.

3. Change index values are interpreted

+.5 and greater	(+++)	significant positive change
-.5 and less	(---)	significant negative change
+.35 to +.49	(00++)	probable positive change
-.35 to -.49	(--00)	probable negative change
+.25 to +.34	(0+)	possible positive change
-.25 to -.34	(-0)	possible negative change

4. Those values unlikely to change (00) are interpreted as those with change indices of 0 to +.24 and -.24 to 0
AND
with the proportion of respondents choosing "probably same" equal to or greater than 50%.

5. No interpretation is indicated where there was no panel consensus.

GROUP-ORIENTED VALUES

		TOTAL N	SCORE	INDEX	INTERPRETATION
1	Respectability	98	17	-.17	
2	Rectitude and Personal Morality	100	9	+.09	00
3	Reasonableness and Rationality	88	13	+.15	00
4	The Domestic Virtues	98	-28	-.29	-0
5	The Civic Virtues	92	-18	-.20	
6-A	Devotion to Family, Duty	97	23	-.24	00
6-B	Personal Responsibility and Accountability	97	6	+.06	
6-C	Devotion to Principle	91	-50	-.55	---
7-A	Friendship Proper	98	18	+.18	00
7-B	Loyalty	99	9	+.09	00
7-C	Friendliness, Kindliness, etc.	96	18	+.19	00
7-D	Fellow-Feeling	98	26	+.27	0+
7-E	Gregariousness	99	11	+.11	00
7-F	Receptivity	99	17	+.12	00
7-G	Personal Tolerance	99	51	+.51	+++
7-H	Patience	92	15	+.16	
8	Service	100	23	+.23	
9	Generosity	99	- 4	+.04	00
10	Idealism	99	19	+.19	
11	Recognition	100	-18	-.18	00
12	Forthrightness	100	27	+.27	0+
13	Fair Play	97	- 2	-.02	00

SOCIETY-ORIENTED VALUES

		TOTAL N	SCORE	INDEX	INTERPRETATION
1	Social Welfare	92	63	+.68	+++
2-A	Tolerance	97	42	+.43	00++
2-B	Fair Play	94	35	+.37	00++
2-C	Civil Rights	93	31	+.33	0+
3	Justice	97	46	+.47	00++
4	Liberty	96	29	+.30	0+
5	Order	97	27	+.28	0+
6	Opportunity	97	- 4	-.04	00
7	Charity	95	- 2	-.02	00
8	Progressivism Optimism	98	- 2	-.02	00
9	Pride in "our culture"	98	-36	-.37	--00

NATION-ORIENTED VALUES

		TOTAL N	SCORE	INDEX	INTERPRETATION
1-A	National Freedom and Independence	97	-35	-.36	--00
1-B	National Prosperity and Achievement	97	-28	-.29	-0
1-C	Patriotism and National Pride	96	-46	-.48	--00
1-D	Concern for the National Welfare	98	-11	-.11	
1-E	Loyalty (to country)	96	-33	-.34	--0
1-F	Chauvinism	94	-62	-.66	---
2	Democracy and "The American Way"	94	-41	-.44	--00
3	"Public Service"	94	3	+.03	

MANKIND-ORIENTED VALUES

		TOTAL N	SCORE	INDEX	INTERPRETATION
1-A	Peace	98	54	+.55	+++
1-B	Material Achievement and Progress	96	-13	-.14	
1-C	Cultural and Intellectual Achievement and Progress	97	45	+.46	00++
2	Humanitarianism	99	48	+.48	00++
3	Internationalism	96	53	+.55	+++
4	Pride in the Achievements of "The Human Community"	96	36	+.38	00++
5	Reverence for Life	98	21	+.21	
6	Human Dignity	98	33	+.34	0+

ENVIRONMENT-ORIENTED VALUES

		TOTAL N	SCORE	INDEX	INTERPRETATION
1	Aesthetic Values	100	61	+.61	+++
2	Novelty	81	4	+.05	

It is likely that Tolerance, Fair Play, and Justice will grow in importance as society-oriented values, but it is also likely that Pride in "Our Culture" will decline in importance.

The panel estimated that it is somewhat likely that the future will bring increased importance for Civil Rights, Liberty, and Order.

For the remaining three values - Opportunity, Charity and Progressivism Optimism - it was the opinion of the panel that no change in importance will occur in the future.

Nation-Oriented Values

The panel thought there will be a significant shift in one nation-oriented value. It believed there will be a sharp lessening in importance of Chauvinism (that is, nationalism and pride in national power and preeminence) during the next thirty years.

Less importance is likely for National Freedom and Independence, Patriotism and National Pride, and Democracy and the "American Way".

According to the panel, it is somewhat likely that there will be a decrease in importance for two other nation-oriented values: National Prosperity and National Achievement Generally and Loyalty to Country.

Regarding Concern for the National Welfare and "Public Service", there was no panel consensus.

Mankind-Oriented Values

Significant changes in the direction of more importance were foreseen by the panel for Peace and Internationalism.

The panel also agreed that three other mankind-oriented values - Cultural and Intellectual Achievement and Progress, Humanitarianism, and Pride in the Achievements of the Human Community - are likely to increase in importance to Americans.

Somewhat likely to increase in importance is Human Dignity, according to the panel.

There was no panel consensus in the case of Material Achievement and Progress and Reverence for Life.

Environment-Oriented Values

There were only two values listed in this category, and one of these - Aesthetic Values (Environmental Beauty) - was estimated by the panel to become significantly more important in the future.

There was no consensus among the panel about Novelty.

Several caveats are in order here. Although broadly based, the panel is a very limited one numerically, and it undoubtedly is not representative of the entire U.S. population, about whose changing values we are concerned. Although Round One panelists did not supply information as to their educational attainment and economic status, it seems reasonable to infer from the positions they held and the functions they reported performing, that this is a group of relatively affluent and well-educated persons. As revealed earlier, 39% of Round One panelists were academics and another 27% were government staff members - two categories where formal job requirements usually stress education. Another 10% were commercial representatives and an equal proportion were consultants, occupational categories which ordinarily are associated with better-than-average education and income. We are least certain about the educational attainment and income level of the private and public interest group representatives and private citizen category, but this group only represents the final 14% of the total panel. The panel was not chosen for its expertise about American values - that is, no member of the panel, so far as we know, had made an intensive study of American values and their changing character over time. On the other hand, it seems reasonable to infer - again from the positions held and the functions performed - that the panelists were more apt than the general population to be aware of, and familiar with, present and impending large-scale problems and prospects which might be expected to collide with human values. In some ways, then, the value configuration produced by the panel may represent a "hoped for" future value set and, indeed, a few panelists noted that qualification of their responses.

There was a Round Two iteration of those value items for which no panel consensus could be reached on Round One, and it is reported fully in the Appendix. There were seventy-three usable responses to the iteration. Among Self-Oriented Values, three which were submitted to the panel again produced once more no consensus: Personal Security, Competence, and Faith. In the case of Self-Control, the panel thought no change in importance was likely. For another value, Personal Liberty, the group judgment was altered to a "somewhat likely to be more important" position. Finally, the panel's second assessment of Appreciation and Appreciativeness changed to "probably more important".

In the case of Group-Oriented Values, re-assessment by the panel

RESULTS OF ROUND TWO VALUES ITERATION

		TOTAL N	SCORE	INDEX	INTERPRETATION
Self-Oriented Values					
1-C	Personal Security	73	+16	+.22	
4	Personal Liberty	72	+20	+.27	0+
7-C(4)	Self-Control	69	+ 2	+.03	00
7-D	Competence	73	- 7	-.10	
7-H	Faith	73	+14	+.19	
7-I	Appreciation and Appreciativeness	71	+27	+.38	00++
Group-Oriented Values					
1	Respectability	69	-21	-.30	-0
5	The Civic Virtues	70	-30	-.43	--00
6-B	Personal Responsibility	73	- 2	-.03	
7-H	Patience	71	+12	+.16	00
8	Service	71	+22	+.31	0+
10	Idealism	73	+24	+.33	0+
Nation-Oriented Values					
1-D	Concern for the National Welfare	71	-36	-.50	---
3	"Public Service"	72	-20	-.28	-0
Mankind-Oriented Values					
1-B	Material Achievement and Progress	73	-12	-.16	
5	Reverence for Life	68	+27	+.37	00++
Environment-Oriented Values					
3	Compatibility Between Ecosystem and Human System Functioning	73	+54	+.74	+++
4	Regard for Natural Resources	73	+51	+.70	+++
5	Regard for All Forms of Life	73	+38	+.52	+++

resulted in no consensus for only one of the six value items considered: Personal Responsibility and Accountability. Upon second consideration, the panel thought that Respectability is somewhat likely to decrease in importance. The Civic Virtues, according to the Round Two panel, probably will diminish in importance to Americans. No change was the panel's re-considered judgment for Patience, while the group thought Service and Idealism are somewhat apt to become more important.

Two Nation-Oriented Values were re-submitted to the panel. For one of these - Public Service - the panel believed a decline in importance was somewhat likely. For the other - Concern for the National Welfare - the panel estimated a significant decline in importance.

Of the two Mankind-Oriented Values re-assessed by the panel, Reverence for Life was judged likely to become more important, but the panel once again could reach no consensus about Material Achievement and Progress.

Three Environment-Oriented Values, suggested by a number of panelists in Round One, were assessed by the entire panel for the first time in Round Two. For all three values - Compatibility Between Ecosystem and Human System Functioning, Regard for Natural Resources, and Regard for All Forms of Life - the panel saw a significant increase in importance.

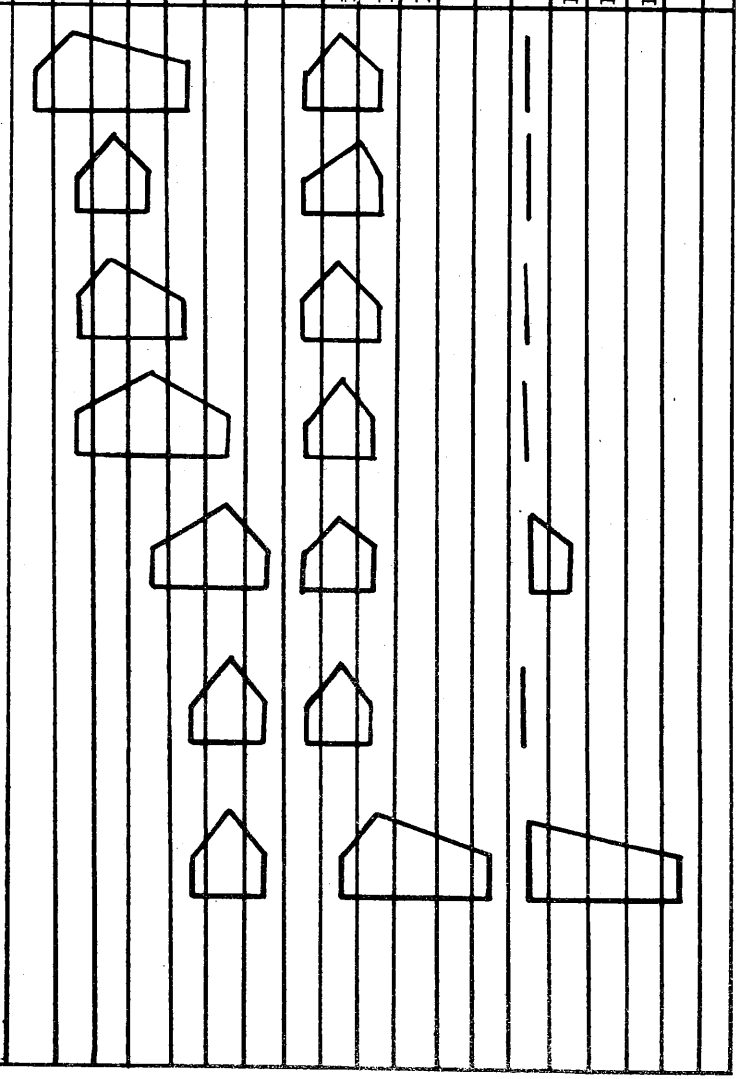
These results do not alter the previously-noted general patterns established by the Round One panel for each value category. The important change was the addition of three new Environment-Oriented Values which will become significantly more important in the future, according to the Round Two panel.

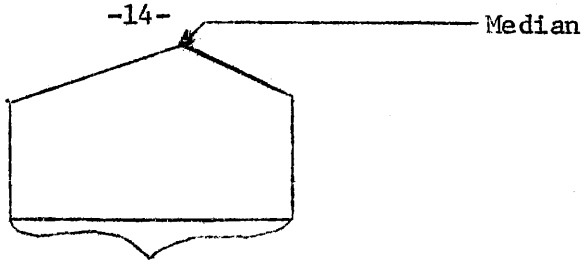
Results: Ranking of Potential Problems Presented to Panelists

The Round Two Inquiry forms presented to panelists seven potential problems and their related possible events and alternative actions which may be of future concern in the utilization of water resources. Respondents were requested to check their responses to several questions related to each problem, event, and action, and they also were asked to assign a rank-order to each problem identifying its relative importance.

The table which follows illustrates the rankings which the panel - as a group - assigned. The figures in the columns can be interpreted as follows:

POTENTIAL PROBLEM	Rank							With current trends, when will the problem be a national issue?						When should action be taken at the nation level?					
	1	2	3	4	5	6	7+	Now	In 5 years	In 10 years	In 20 years	Later	Never	Now	In 5 years	In 10 years	In 20 years	Later	Never
1. Demand for and abuse of water resources resulting from increasing affluence (i.e., continued growth in GNP per capita).																			
2. Demands on water resources (for example, nuclear power plant cooling, production and transportation of fuels) resulting from energy consumption.																			
3. The relative rights and responsibilities of Federal, regional, state and local authorities, and public and private interest groups in the planning and management of water resources.																			
4. Public confidence in officials (including technical specialists) and in the information they provide, regarding planning and managing the use of water resources.																			
5. Demand for water borne transportation requiring additional port facilities that encrouch upon and pollute water and contiguous land resources which otherwise could be devoted to wilderness, recreation, aesthetic and other uses.																			
6. Reduction in the availability of beaches and shorelines due to erosion and/or private use. (In this case many of the panelists felt that the problem should clearly be broken into two parts -- those generated by erosion and those generated by private use of such areas.)																			
7. Population mobility and consequent public apathy toward water resources decisions of the community. (Responses indicated that population mobility itself is probably not the primary factor in contributing to such apathy and that this aspect should be deleted from the problem statement.)																			





Interquartile Range

Although there was considerable overlap among the first four problems as ranked by the panel, it is clear that the group considered "Demand for and abuse of water resources resulting from increasing affluence" to be of primary importance among the entire list of problems. The median rankings assigned to the second- and third-ranked problems ("Demands on water resources resulting from energy consumption" and "The relative rights and responsibilities of federal, regional, state and local authorities and public and private interest groups in the planning and management of water resources") were almost identical, but the interquartile range for the third-ranked problem was greater. The fourth-ranked problem - "Public confidence in officials and in the information they provide, regarding planning and managing the use of water resources" - received a rather wide range of rankings, by contrast with the second- and third- ranked problems. The problem which was ranked fifth by the panel - "Demand for water borne transportation requiring additional port facilities that encroach upon and pollute water and contiguous land resources which otherwise could be devoted to wilderness, recreation, aesthetic, and other uses" - was awarded an interquartile range from four through seven, with a median ranking of six. We are least certain about the importance assigned to the problems ranked number six and number seven by the panel. These are "Reduction in the availability of beaches and shorelines due to erosion and/or private use" and "Population mobility and consequent public apathy toward water resources decisions of the community." In the case of the sixth-ranked problem, many of the panelists thought the problem should be broken down into two parts, one dealing with erosion and the other dealing with private use. Concerning the seventh-ranked problem, many panelists indicated they thought population mobility itself probably is not a factor contributing to apathy and should be deleted from the problem statement. It is difficult to know how the rank-ordering of these problems was affected by these criticisms. When considering only the first four problems - which seem to be distinctly set off from the remainder by their rankings - it seems that this panel

awarded high priority to those water resources problems stemming from growth, affluence, and life style (i.e., high energy use) on the one hand and to those problems arising from shaken public confidence in officialdom and from conflicting jurisdictional demands from various governmental and non-governmental groups on the other hand. Of course, it must be remembered that the panel ranked only those problems submitted to it in Round Two, and thus did not consider a wider range of problems.

Results: Panel Estimates of National Issue Status of Problems and Recommendations for Timing of Actions

The preceeding table reports Round Two panel judgments about the likelihood and timing of national issue status for each of the seven problems. It is striking that, for the first six problems (as ranked by the panel), the interquartile range lies between "now" and "In 10 years", and the medians almost uniformly are placed within the "In 5 years" category. These are - in the view of most panelists - "immediate" or "near future" problems in terms of national awareness. Only in the case of the seventh-ranked problem was there a broad range of estimates, with some panelists suggesting that it would never be a national issue, and the median estimate falling within the ten-year category. However, it must be remembered that dissatisfaction with the problem statement was apparent and may have influenced these judgments.

For each of the seven problems the panel thought that action should be taken at the national level "now". The interquartile ranges and medians for all the problems except numbers 5 and 7 fell within the "now" category. Only in the case of the last problem was the interquartile range broadly distributed.

Results: Round Two Panel Judgments About the Impact and Effectiveness of Events and Actions

It was necessary to utilize additional criteria to determine if there was Round Two consensus concerning the impact of possible events and the effectiveness of suggested actions. These criteria are shown in the Appendix. Upon application of the criteria, sixteen of the original twenty-nine events were judged to be of significant or moderate impact. There was no consensus on only six of the original events, and they were included in the Round Three inquiry for reconsideration. The remainder - which were, according to the criteria, of insignificant or no impact - were dropped from further consideration by the panel.

In the case of suggested actions, these were grouped in categories based upon the judgments about their effectiveness in preventing or minimizing the problem. These categories, along with the criteria determining them, are shown in the Appendix. When the criteria were applied, eighteen of the twenty-one original actions were judged to be highly or moderately effective and only one was included for Round Three reconsideration because of no consensus.

These impact and effectiveness results are indicated in the following summary.

PROBLEM: Demand for and abuse of water resources resulting from increasing affluence (i.e., continued growth in GNP per capita.)

Possible Events

Significant negative impact:

-All U.S. waste disposal systems operate on a closed loop basis.

-Systems for monitoring, predicting, and controlling pollution sources are developed.

Moderate negative impact:

-An earth satellite is established for generating electric power (about one million kilowatts) and beaming it to the earth's surface by microwaves.

-U.S. population is stabilized.

Suggested Actions

Highly effective:

-A major federally supported R&D program to develop fail safe systems, closed loop waste management systems, and systems for handling accidental discharges.

-Taxation of individuals and organizations based upon the amount and type of water resources used and the resulting effects.

Moderately effective:

-Government effort to stabilize or reduce economic or industrial growth.

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PROBLEM: Demands on water resources (for example, nuclear power plant cooling, production and transportation of fuels) resulting from energy consumption.

Possible Events

Significant positive impact:

-One-third of fresh water runoff in the U.S. is used to cool power plants.

-Nuclear power provides about 55% of the electrical needs of the U.S. (1970=1%)

-Oil shale industry requires 4.8 million barrels of water per day to produce approximately 15% of U.S. petroleum.

Moderate negative impact:
-Large-scale, low-profile cooling towers for carrying off waste heat from electric power stations come into widespread use.

Suggested Actions
Moderately effective:
-Stabilization of U.S. population.
-Federal legislation limiting all uses of electrical energy.

***

PROBLEM: The relative rights and responsibilities of federal, regional, state and local authorities and public and private interest groups in the planning and management of water resources.

Possible Events
Moderate positive impact:
-At least 80% of the population lives in urban areas (1970=73.5%)
No consensus:
-Construction grants for sewage treatment facilities are made on a regional or area-wide basis, rather than on a city or town basis as in the past.
-Metropolitan area-wide policy control fails to such an extent that local government transfers many key functions to state and national government.
-The Federal government acquires all urban land.

Suggested Actions
Highly effective:
-Legislation, possibly a constitutional amendment, establishing regional water resources agencies whose authority transcends state boundaries and who are required to coordinate on a national level.
Moderately effective:
-Federal legislation defining authorities of the states vis-a-vis the Federal government regarding funding, planning, and management of water resources.

***

PROBLEM: Public confidence in officials (including technical specialists), and in the information they provide, regarding planning and managing the use of water resources.

Possible Events
Significant negative impact:
-Legislation establishes broad federal controls over the manufacture, distribution, and use of nearly all industrial chemicals.
No consensus:
-Developers are permitted to pre-empt restrictive local or state building codes in order to use federally approved construction standards.
-Metropolitan area-wide policy control fails to such an extent that local government transfers many key functions to state and national government.

Suggested Actions

Moderately effective:

-Establishment of rigorous job performance standards including qualification tests for initial hiring and promotion.

-Personnel rotation among various governmental agencies (e.g., water resources, transportation, urban planning, etc.) in order to broaden viewpoints and management capabilities.

-Hiring of industrial executives for government service with a background of success in planning and management.

-Widespread public dissemination of newsletters and articles discussing plans and accomplishments.

***

PROBLEM: Demand for water borne transportation requiring additional port facilities that encroach upon and pollute water and contiguous land, resources which otherwise could be devoted to wilderness, recreation, esthetic, and other uses.

Possible Events

Significant positive impact:

-85% of U.S. oil is imported (approximately 10% in 1970)

-Annual volume of oceanborne transportation reaches 4,000 million long tons (1970=2,500 million long tons)

-Domestic shipment of goods by water exceeds that by rail (1970 water tonnage - 60% of rail tonnage)

Moderate negative impact:

-A chemical is developed capable of completely dissolving oil spilled on water surfaces.

No consensus:

-A transportation system is established using 1,000,000 ton tankers along with sea berths and petroleum tanks.

Suggested Actions

Moderately effective:

-A major federally supported R&D program to develop fail-safe systems, closed loop waste management systems, and systems for handling accidental discharges.

-Federal legislation specifying the relative distribution among use of various transportation modes, including the possibility of government subsidies.

-Taxation of various transportation modes on the basis of historical records of accidents, spills, and other forms of environmental pollution.

No consensus:

-Government effort to stabilize or reduce economic or industrial growth.

***

PROBLEM: Reduction in the availability of beaches and shorelines due to erosion.

Suggested Actions

Highly effective:

-Government purchase of shoreline and beach property containing antiquated structures to make areas available for redevelopment or allocation to public uses.

Moderately effective:

-Major government programs to develop artificial bodies of water.

***

PROBLEM: Reduction in the availability of beaches and shorelines due to private use.

Possible Events

Significant positive impact:

-Fifty percent of Americans own second homes (1967=2.9%)

-Americans spend 6.3% of their time on vacation (1900=2.5%, 1950=2.6%)

***

PROBLEM: Public apathy toward water resources decisions of the community.

Suggested Actions

Moderately effective:

-Hiring of professionals at the community level with authority for all water resources decisions and who are required to publish newsletter reports, etc. on all plans and actions.

-Establishment of action groups, funded by local communities and/or the states, to aggressively seek public involvement.

***

The seven possible events dropped from further consideration at the end of Round Two are listed in the Appendix, together with the two suggested actions which were judged to have little or no impact.

Results: Barriers to Implementation of "Effective" Actions

An important conclusion from Round Two is that uniformly large porportions of panelists who noted actions which would prove effective (if it were not for difficulties with implementation) identified institutional and political barriers as the chief impediments. Sixty percent of the "barriers to implementing actions" identified by the respondents were classified by them as institutional or political, as is indicated by the tables which follow. Data are presented for both the actions presented to the panelists and for the new actions suggested by panelists in Round Two in the Appendix.

BARRIERS TO IMPLEMENTING ACTIONS

	Lack of Criteria	Techno-logical	Institu-tional/ Political	Cost	Other	Total
Water Resources Government Representatives (N=17)	8%	5%	66%	16%	5%	100%
General Government Representatives (N=3)	23%	15%	54%	0%	8%	100%
Water Resources Academics (N=14)	13%	9%	59%	12%	7%	100%
General Academics (N=16)	10%	9%	54%	17%	10%	100%
Private and Public Interest Representatives (N=13)	19%	4%	62%	6%	9%	100%
Commercial Representatives (N=5)	26%	0%	53%	21%	0%	100%
Consultants (N=6)	0%	12%	70%	18%	0%	100%
All Respondents (N=74)	11%	8%	60%	14%	7%	100%

NOTE: Percentages do not represent proportions of respondents, but rather indicate proportions of the total number of "barriers to implementing actions" checked by the respondents in each respondent category.

BARRIERS TO IMPLEMENTING SPECIFIC
ACTIONS AS REPORTED BY ROUND TWO PANELISTS

ACTION	Lack of Criteria	Techno-logical	Institu-tional/ Political	Cost	Other
Stabilization of U.S. population.	12% (5)*	10% (4)	57% (24)	7% (3)	14% (6)
Federal legislation limiting all uses of electrical energy.	13% (5)	3% (1)	71% (27)	3% (1)	10% (4)
A major federally supported R & D program to develop fail-safe systems, closed loop waste management, and systems for handling accidental discharges.	8% (3)	15% (6)	42% (17)	30% (12)	5% (2)
Widespread public dissemination of newsletters and articles discussing plans and accomplishments.	0% (0)	0% (0)	50% (1)	0% (0)	50% (1)
Hiring of industrial executives for government service with a background of success in planning and management.	0% (0)	0% (0)	100% (2)	0% (0)	0% (0)
Government effort to stabilize or reduce economic or industrial growth.	17% (8)	11% (5)	57% (27)	4% (2)	11% (5)
Federal legislation defining authorities of the states vis-a-vis the Federal government regarding funding, planning, and management of water resources.	10% (1)	0% (0)	90% (9)	0% (0)	0% (0)

* Percentages do not represent proportions of respondents, but rather indicate proportions of the total number of "barriers to implementing actions" checked by the respondents.

Legislation, possibly a constitutional amendment, establishing regional water resources agencies whose authority transcends state boundaries and who are required to coordinate on a national level.	0% (0)	0% (0)	100% (18)	0% (0)	0% (0)
Establishment of rigorous job performance standards including qualification tests for initial hiring and promotion.	22% (2)	11% (1)	56% (5)	11% (1)	0% (0)
Federal legislation specifying the relative distribution among use of various transportation modes, including the possibility of government subsidies.	15% (3)	0% (0)	70% (14)	10% (2)	5% (1)
Personnel rotation among various governmental agencies in order to broaden viewpoints and management capabilities.	22% (2)	0% (0)	56% (5)	11% (1)	11% (1)
Taxation of individuals and organizations based upon the amount and type of water resources used and the resulting effects.	22% (6)	3% (1)	59% (16)	7% (2)	7% (2)
Taxation of various transportation modes on the basis of historical records of accidents, spills, and other forms of environmental pollution.	23% (5)	5% (1)	48% (10)	14% (3)	10% (2)

Major government programs to develop artificial bodies of water.	0% (0)	0% (0)	50% (4)	38% (3)	12% (1)
Hiring of professionals at the community level with authority for all water resources decisions and who are required to publish newsletter reports, etc., on all plans and actions.	0% (0)	0% (0)	33% (3)	33% (3)	33% (3)
Establishment of action groups, funded by local communities and/or the states, to aggressively seek public involvement.	16% (3)	6% (1)	56% (10)	16% (3)	6% (1)
Government purchase of shoreline and beach property containing antiquated structures to make areas available for redevelopment or allocation to public uses.	9% (2)	5% (1)	48% (10)	38% (8)	0% (0)

The Appendix focusses upon the comments of panelists concerning each impeded action.

It is apparent that this panel thought there were few technological barriers to implementing actions. Only 8% of the total number of barriers identified by the entire panel fell into this category. Commercial Representatives were even more emphatic; none of the barriers they identified were technological, while General Government Representatives indicated that 15% of all the barriers were technological. Cost was identified as a barrier in varying proportions, ranging from 0% of the time (General Government Representatives) to 21% of the time (Commercial Representatives). Considering the responses of everyone, cost accounted for 14% of the barriers. Similarly, lack of criteria as a barrier was not identified by Consultants at all, but General Government Representatives (26%) regarded that sort of barrier as rather important.

Comments about the exact nature of these barriers appear in the Appendix mentioned previously.

Results: Specific Round Three Problems, Events, and Actions

Round Three (Part One) was a consolidation of inputs from the previous two rounds for the purposes of reiterating some judgments, making some new judgments, and linking values perceptions specified in Round One to specific actions being considered by the panel. The Appendix contains a set of Round Three (Part One) forms complete with frequencies for each response category.

The request of panelists to indicate when each problem is likely to become a national issue did not work well. In almost all cases, the number of panelists who did not answer the question was sufficiently large as to make the results doubtful. Whether this was due to the placement of the item on the Round Three forms, the panel's difficulty with making this sort of judgment, or some other factor is not known. There were other difficulties with Round Three, and these are discussed in some detail in a subsequent section of this report.

In addition to the response frequencies for Round Three, the Appendix also presents a statistical analysis for each item, showing (for events) the median and interquartile range for timing of implementation. Finally, it indicates the proportion of respondents checking conflict between each action and the value categories for each value category cell containing

23% or more of the respondents.

Attention at this point will be confined to those events and actions from Round Three where the sum of the "never" and "no answer" category responses (for the timing questions) was less than 25%. Using this procedure, those items will be eliminated from discussion for which a substantial proportion of the panel did not respond and thought the occurrence of the event unlikely or the implementation of the action to be unwise.

The following several pages present these "high response" events and actions under each potential problem. After each event, a number is indicated, showing the panel's median judgment about the number of years which will elapse before the event will be likely. Following that number are initials showing the impact the panel judged that event would have upon the problem.[1] Similarly, after each action is a number (or the letter N for "now"), showing the panel's median judgment as to the implementation timing for that action. If 23% or more of the panel checked a conflict between that action and any of the value categories, initials are shown which identify the categories.[2]

PROBLEM: DEMAND FOR AND ABUSE OF WATER RESOURCES RESULTING FROM INCREASING AFFLUENCE.

Event: (#2) Systems for monitoring, predicting and controlling pollution sources are developed. 10
(#3) Doubling, from the 1971 level, of the number of persons involved in service-connected industries. 20 - NI
(#6) Doubling, from the 1971 level, in the number of non-residents (transients) using recreational facilities. 10 - M+

Action: (#1) A major federally supported R&D program to develop fail safe systems, closed loop waste management systems, and systems for handling accidental discharges. N
(#2) Taxation of individuals and organizations based upon the amount and type of water resources used and the resulting effects. N - Se
(#4) Strict pollution control regulations which ensure that all costs of production are included in the cost of products. 5 - Se,G,So

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[1] S+ is Significant Positive Impact; S- is Significant Negative Impact; M+ is Moderate Positive Impact; M- is Moderate Negative Impact; NI is No Impact; and NC is No Consensus.

[2] Se is Self; G is Group; So is Society; N is Nation; M is Mankind; and E is Environment.

(#5) Major public investment in R&D to lower cost of pollution control. N
(#7) Government sponsored advertising campaigns by "Public Action Groups" describing costs and benefits accruing from economic growth. 5 - G
(#9) Charges to users which include the total cost of water delivery. N - Se
(#12) Environmental education programs for all schools, which stress the benefits of reduced consumption and resource conservation. N

PROBLEM: DEMANDS ON WATER RESOURCES RESULTING FROM ENERGY CONSUMPTION

Event: (#2) Nuclear power provides about 55% of the electrical needs of the U.S. (1970=1%) 20
(#4) Large-scale, low-profile cooling towers for carrying off waste heat from electric power stations come into widespread use. 10
(#5) Technology becomes available for offshore nuclear power plants which can be ocean-cooled. 10 - M-
(#8) Widespread use of waste heat for industrial purposes. 10 - M-
(#9) Development of an economic power plant which does not use a heat cycle. 20 - S-
(#10) Rationing of fossil fuel exports to the U.S. by other nations. 20 - M+
(#11) Marked improvements in the ability to generate energy from nuclear systems (e.g., reduction in thermal pollution) 10 - NC

Action: (#4) Intensification of government research for solar energy as a major power source. N
(#5) Major government R&D on technology for increasing efficiency in using water, including recycling. N
(#9) Penalizing manufacturers who produce "throw-away" and short-life products. 5
(#10) Penalize manufacturers for "style" changes in appliances and rewarding durability and low energy consumption designs. N
(#12) Federal planning of water requirements in relation to energy usage including national coordination of energy producing facilities and a mixing of systems. N
(#15) A program to develop completely closed cycle power plants having their own cooling ponds. N
(#18) Concerted programs to define the nature of various pollution problems. N - G
(#19) Major programs to define alternative means of a) power plant cooling and for b) improving production efficiencies. N
(#20) Government programs encouraging use of low energy consuming devices. N
(#21) Major federally sponsored program on cooling tower and nuclear waste disposal technology. N
(#22) Major federally sponsored research program on fusion power.
(#23) Major programs to develop new methods for recovery and use of waste heat. N

(#24) A program developed species of fish or shellfish which can be cultivated in heated effluents from power plants. 5
(#26) Major programs to increase efficiencies of power transmission. N
(#37) Federal legislation providing substantial research funds to develop alternative sources of power. N
(#38) Creation of model low energy consumption communities to demonstrate that alternative life styles with less energy consumption per capita are possible. 5
(#40) Development of advanced power transmission system (e.g., superconducting supergrids). 5
(#41) Development of offshore ocean and lake siting for power stations. 10
(#43) Revision of energy rate structures to reduce socially wasteful energy uses. N - Se
(#44) Development of a strong research program on more efficient energy generation, transmission, and use with significant attention devoted to socio-economic factors. N
(#45) A major federally supported R&D program to improve technology. N

PROBLEM: THE RELATIVE RIGHTS AND RESPONSIBILITIES OF FEDERAL, REGIONAL, STATE AND LOCAL AUTHORITIES AND PUBLIC AND PRIVATE INTEREST GROUPS IN THE PLANNING AND MANAGEMENT OF WATER RESOURCES.

Event: (#5) Increasing competition with a doubling of land costs from 1971, for shoreline and riverfront property. 10 - M+
(#6) Quality of water-based recreation is markedly degraded (e.g., greatly increased pollutants from industry, from recreational activities, crowding from 1971 levels.) 10 - M+
(#7) Passage of a federal land-use policy bill. 5 - M+

Action: (#1) Legislation, possibly a constitutional amendment, establishing regional water resources agencies whose authority transcends state boundaries and who are required to coordinate on a national level. 5 - G,N
(#2) Federal legislation defining authorities of the states vis-a-vis the federal government regarding funding, planning, and management of water resources. 5
(#3) Legislation designating and protecting wild river areas and preserved areas from encroachment. N
(#4) Government action to eliminate graft and corruption in government (housecleaning). N
(#7) Termination of water supplies to industries and municipalities which do not remove pollutants before discharge. 5 - G,N
(#11) Research to develop alternative methods of waste disposal, with special funding of sewage disposal process. N
(#14) Increased public participation in planning, arranged by federal agencies with planning responsibility. N
(#18) Increased federal funding to states for water planning and applied research. N
(#19) Increased emphasis on resource planning in city planning educational courses. N
(#20) Establishment of a federal-interstate organization for regional water management. N

PROBLEM: PUBLIC CONFIDENCE IN OFFICIALS (INCLUDING TECHNICAL SPECIALISTS), AND IN THE INFORMATION THEY PROVIDE, REGARDING PLANNING AND MANAGING THE USE OF WATER RESOURCES.

Event: (#4) A major disaster occurs from a nuclear power plant. 20 - S+
(#6) Marked growth in provisions for "outside" review of local activities, i.e., state, regional, and federal "rules of the game" become increasingly numerous and encompassing. 5 - NI

Action: (#1) Establishment of rigorous job performance standards including qualification tests for initial hiring and promotion. N - Se
(#4) Widespread public dissemination of newsletters and articles discussing plans and accomplishments. N
(#7) Elimination of graft and corruption in campaign practices. N
(#8) Formal retraining of governmental officials and specialists including increased sabbaticals for a broader cross section, especially those in planning roles. N
(#10) Public participation at all stages of planning and management. N
(#11) Participation of elected community representatives in water resources policy planning at all levels. N
(#12) Programs presented via mass media which are designed to increase public awareness of potential water resources policies and alternatives. N
(#13) Public hearings, to assess public needs, as a basis for policy formulation. N
(#14) Federal legislation requiring that affected persons be notified, prior to public hearings, that their property is being considered for condemnation and that such persons be given access to any studies that show supposed necessity for such actions. N
(#16) Provision of sabbaticals for federal, industrial, and university people on experiential learning - in relevant task assignments - at select environmental centers to build mutuality. N
(#17) A systematic well-financed effort to actively involve the public in planning decisions. N
(#18) An educational program using mass media and political action to make "officials" more closely related to people. N
(#19) Courses in grammar and high schools to educate children and young people on basic factors involved in planning, with planners as visiting instructors. N
(#21) Public education on environmental problems in schools and colleges. N
(#22) Programs of continuing education for professionals. N
(#23) Short courses and conferences for PhDs in field. N
(#24) Government and/or private programs supporting national educational TV programs on water resources. N
(#25) Revision of tax structures to limit loopholes and subsidies. N
(#26) Limitation on the tenure of congressional committee chairmen. N
(#31) Reorientation of planning to multi-discipline, multi-objective approaches. N

PROBLEM: PUBLIC CONFIDENCE IN OFFICIALS (INCLUDING TECHNICAL SPECIALISTS) AND IN THE INFORMATION THEY PROVIDE, REGARDING PLANNING AND MANAGING THE USE OF WATER RESOURCES - Continued.

(#32) Use of technology assessment procedures in water resources planning and development. N
(#36) Establishment of closer liaison among public officials and university research groups working on fundamental aspects of water use and human carrying capacities. N
(#37) Federal legislation requiring an increased public role in water resource planning. N
(#38) Federal legislation requiring all cities and states to implement uniform pollution monitoring techniques and to publicly report results in a meaningful manner. N
(#40) Establishment of multipurpose or regional planning, including land use, power, water, and transportation in an overall scheme. N
(#41) Expanded use of performance budgeting to help public and government officials know what bills go with what programs. N
(#42) Establishment of ombudsmen or other individuals able to respond effectively to individuals voicing complaints. N
(#43) Presentation of alternatives reflecting different value orientations to public. N

PROBLEM: DEMAND FOR WATERBORNE TRANSPORTATION REQUIRING ADDITIONAL PORT FACILITIES THAT ENCROACH UPON AND POLLUTE WATER AND CONTIGUOUS LAND, RESOURCES WHICH OTHERWISE COULD BE DEVOTED TO WILDERNESS, RECREATION, ESTHETIC, AND OTHER USES.

Event: (#6) A major accident involving a 1,000,000 ton tanker. 10 - MH
(#7) Development of huge cargo aircraft, twice the size of the current C-5A. 10 - NI

Action: (#1) A major federally supported R&D program to develop fail-safe systems, closed loop waste management systems, and systems for handling accidental discharges. N
(#5) Increased utilization of rail systems. N
(#7) Public pressure directed at insuring government licensing, regulation, and subsidizing only in the public interest (not in response to pressures of clientele government is supposed to supervise). N
(#8) Establishment and enforcement of international regulations on pollution of water resources. N
(#10) Establishment of regulations governing discharge at sea. N
(#11) Regulations which make the total cost for cleanup of water-borne spills and other pollution incumbent on the responsible carrier. N
(#14) Major federal program to preserve freshwater and saltwater coastlines for recreation. N

PROBLEM: REDUCTION IN THE AVAILABILITY OF BEACHES AND SHORELINES DUE TO EROSION

Action: (#1) Government purchase of shoreline and beach property containing antiquated structures to make areas available for redevelopment or allocation for public uses. N - Se
(#6) Government purchase of shorelines where erosion is expected, for controlled public use (to preserve virgin shorelines and dunes). N
(#7) Major programs (federal or state) to protect existing beaches and restore areas where erosion has destroyed the use of beaches. N

PROBLEM: REDUCTION IN THE AVAILABILITY OF BEACHES AND SHORELINES DUE TO PRIVATE USE.

Event: (#4) Cities become more attractive and "liveable" with the "in" thing being the establishment of a comfortable urban home, alleviating the need to flee the city. 20 - M-
(#5) Institution of a four-day work week. 10 - S+
(#6) A major breakthrough occurs in modular housing concepts allowing them to be used in at least 75% of new construction. 10 - M+
(#7) Year-round tourism and recreation become standard for at least 50% of the population. 20 - S+
(#8) Private boat ownership triples from the 1971 level. 20 - S+
(#9) Widespread formation of clubs to acquire beaches and shorelines for private, restricted use. 10 - S+

Action: (#1) Government purchase of high quality resilient beach lands. N
(#3) Establishment of strict shoreline development regulations. N
(#4) Major programs to rebuild cities and improve the urban environment. N
(#8) Government purchase of shoreline and beach property containing antiquated structures to make areas available for allocation to public uses. N
(#11) Government development of social cost/benefit methodology for determining real value of beaches and shorelines and for use in determining controls and other programs. N
(#17) Redistribution of the work week to a 7-day basis to even out recreation use of areas. 10 - Se
(#18) Establishment of federal and state planning of coastal use, development and access. N
(#19) Major efforts by government and/or industry to create recreational developments in urban areas. N
(#20) Development and enforcement of national land use policies. N
(#21) Development of procedures to make individuals accountable for any mistreatment of beach or shoreline areas (e.g., litter, vandalism, improper building, etc.) N

PROBLEM: PUBLIC APATHY TOWARD WATER RESOURCES DECISIONS OF THE COMMUNITY.

Event: (#3) A four-day work week becomes the norm. 10 - NI
(#4) Marked increase in the purchase of vacation homes due to increased disposable income. 10 - NI

Action: (#5) Providing creative opportunities for "retired" people. N

PROBLEM: RAPID OBSOLESCENCE OR INEFFECTIVENESS OF WATER RESOURCES PLANS FROM A LACK OF PLANNING ON A REGIONAL AND COMPREHENSIVE SCALE

Action: (#1) Establishment of national goals and nationwide development to identify where growth should occur regarding population distribution and economic developments. N
(#2) Identification of obstacles to growth in sparsely settled areas and development of plans to remove constraints which previously made it impractical for growth to take place in such areas. 5
(#4) Establishment of a Federal "Land Resources Planning Act". N
(#5) Establishment and funding of a unified federal-state open space program. N

PROBLEM: REFUSAL OF BUSINESS TO ACCEPT RESPONSIBILITY FOR ENVIRONMENTAL DAMAGE (e.g., PASSING COSTS ON TO CONSUMER)

Event: (#1) Report is published and widely circulated which clearly presents data on the high cost of pollution control technology. 5 - M+

PROBLEM: "MINING" AND USE OF GROUND WATER FOR MUNICIPAL SUPPLIES, AIR CONDITIONING, IRRIGATION, AND OTHER USES.

Action: (#1) State licensing of groundwater withdrawals. N - Se,G
(#2) Governmental control regulating the amount of water withdraw. N - G
(#3) Recharging of ground water used for air conditioning and for other uses where quality is not materially impaired. N

PROBLEM: ECONOMIC, POLITICAL, AND SOCIAL REWARDS WHICH ENRICH POLLUTERS AT A COST TO THE PUBLIC ENVIRONMENT.

Event: (#1) Economic growth continues to be a major goal of American society. 2 - S+

Action: (#1) Penalize polluters by some factor of the "external" or "social" costs of their damages to public environment. N
(#3) Cancellation of all public subsidies and appropriations to private or public enterprises which pollute by misusing waste discharge, or visual disfiguration. N
(#6) Oblige government agencies to be accountable to the people rather than to privileged clientele. N

PROBLEM: INDUSTRIAL MIGRATION FROM STRICT POLLUTION LAWS WITH A LOSS OF THE ECONOMIC BASE AND LOCALIZED UNEMPLOYMENT.

Event: (#3) Strong water pollution control laws are established. 5 - NC

Action: (#1) Increased research on environmental factors relating to industrial location and on means of selecting sites by industry to minimize adverse environmental impacts. N
(#2) Establishment of a program to provide industry with technical advice on minimizing advance environmental effects in site selection and operation. N

PROBLEM: DEGRADATION OF WATER QUALITY IN WILDERNESS AND WILD AREAS FROM INCREASED VISITATION.

Event: (#1) Complete abolition of the draft enables youth to travel and explore more freely. 5 - NI
(#2) Technological advancements in backpacking equipment enable more people to visit remote areas. 5 - M+
(#3) At least twenty-five percent increase in the number of people who have longer vacations and shorter work-weeks. 10 - S+

Action: (#1) Institution of a permit/reservation system for all wild lands. 5 - Se
(#2) Strong restrictions on the manufacturing and use of all-terrain recreation vehicles. N - Se
(#3) Government and private funding of cities for their revitalization as recreational sites. N

PROBLEM: LAND SUBSIDENCE, OR SALINE WATER ENCROACHMENT, IN COASTAL AREAS FROM WITHDRAWAL OF GROUND WATER.

Action: (#1) Recharging of aquifers from which ground water is withdrawn. N

PROBLEM: INADEQUATE SUPPLIES OF FRESH WATER FOR DOMESTIC AND MUNICIPAL USES (IN CERTAIN AREAS).

Event: (#1) Shortage of water stops growth in many states. 10 - M+
(#2) Areas of water shortage increase and new areas appear. 10 - M+

Action: (#1) Development of desalinization technology. N
(#2) Increases in water use costs to user. N
(#3) Reuse of treated water. N
(#4) Distribution of population and industry to avoid or reduce congestion. 5 - Se,G

PROBLEM: SABOTAGE AND POISONING OF THE WATER SUPPLIES IN SEVERAL LARGE U.S. CITIES.

Action: (#1) Development of improved technology for monitoring water supplies and detecting poisons. N
(#2) Establishing of strong penalties for placing poisons in water supplies. N

PROBLEM: INABILITY (FROM INSUFFICIENT TAXES AND OTHER REASONS) OF MUNICIPAL AND OTHER STATE SUBDIVISIONS TO PROVIDE WATER, SEWAGE DISPOSAL, POLLUTION CONTROL, ETC. SERVICES TO MEET POPULATION DEMANDS.

Event: (#1) Industries are unable to contract for usable water supply (in certain areas). 10 - S+
(#2) Means are found to eliminate virus hazards in wastewater treated for human consumption. 10 - M-
(#3) Lower cost methods of advanced treatment are developed which will allow greater non-domestic reuse of water. 10 - M-

Action: (#1) Increased research on virus problems of treated waste water. N
(#2) Increased research on waste water treatment methods. N
(#6) State legislation providing a broader tax base to assist municipalities in meeting demands for public services. N
(#8) Federal cost sharing legislation that rewards comprehensive regional planning. N

PROBLEM: EXCESSIVE REGULATION AND USE OF LAND FOR FLOOD PLAINS.

Action: (#1) Increased research on ways to distinguish appropriate from inappropriate flood plain development. 20
(#2) Establishment of programs to provide technical advice to individuals and communities on what kind of development is appropriate. N

PROBLEM: MAJOR FLOODS FROM INADEQUATE FLOOD PLAINS.

Event: (#2) Demand for flood protection in urban areas increases by at least 30% from current levels. 5 - NI

Action: (#1) Increased research on ways to better distinguish appropriate from inappropriate flood plain development. N

PROBLEM: MAJOR POLLUTION OF OCEANS AND FOREIGN AREAS ("POLLUTION HAVENS").

Event: (#3) Multi-national corporations double in size and power from 1971 levels in the less developed areas of the world. 10 - H+

Action: (#2) Publicizing firms who seek to evade pollution regulations in the U.S. N
(#3) Establishment of international pollution control standards and effective enforcement for same. N
(#7) Prevention of the military from using the oceans as dumping grounds. N

PROBLEM: REDUCTION, BELOW HEALTH STANDARDS, OF THE QUALITY OF A SUBSTANTIAL PORTION OF THE GROUND WATER IN THE AGRICULTURAL MIDWEST.

Action: (#1) Implementation of a computer information system on groundwater quality. N
(#2)Regional conference to identify and evaluate the problems. N
(#3) Establishment of regional land use controls to manage surface and ground water supplies and quality. 5

PROBLEM: LOSS OF FOOD SUPPLIES FROM MAJOR KILLS OF FISH AND MARSH LIFE DUE TO POLLUTION OF STREAMS AND ESTUARIES.

Event: (#1) Federal policy moves toward uniform national water quality standards with little regard for local special problems. 5 - NC

Action: (#2) Development of systems for monitoring, predicting and controlling pollution sources. N
(#3) Establishment of strict water quality standards in known food sources areas. N
(#4) Establishment of incentive systems to motivate potential polluters to change current and contemplated actions. N

PROBLEM: WORLD FOOD SHORTAGES WHICH RESULT IN "PROTECTIVE WARS" AND EXTREME DANGER TO UNITED STATES.

Event: (#1) Food riots in China, India, Pakistan. 10 - S+

Action: (#1) Major research on fertility control methods. N

PROBLEM: DISPOSAL OF SOLID WASTE.

Event: (#1) Industries develop new minimum bulk containers and/or recyclable containers. 5 - M-

Action: (#1) Legislation minimizing waste accrual by requiring use of minimum bulk containers, limiting direct mail advertising, etc. N
(#2) Legislation requiring recycling of waste. 5

PROBLEM: CONCENTRATIONS OF MAN-MADE CHEMICAL POLLUTANTS IN NATIONAL WATERWAYS

Action: (#2) Improvements in monitoring equipment enabling more accurate detection of new chemicals in ecological systems. N
(#3) Establishment of a large scale federal program to develop biological pest controls. N
(#4) Strong restrictions on the manufacture and sale of chemical pesticides. N
(#5) State and federal government grants to local schools and communities to develop environmental education programs to alert people to the consequences of the use of synthetic chemicals. N

PROBLEM: POLLUTION OF AQUIFIERS

Event: (#2) Underground disposal of wastes doubles. 10 - S+

Action: (#1) Mapping and charting of underground water supplies. N
(#2) Regulation of well drillers. N - Se
(#3) Establishment of control, at the state level, of well recharging. N

PROBLEM: EUTROPHICATION OF LAKES, RIVERS, AND STREAMS.

Event: (#1) Marked increase in construction of second homes on lakes. 5 - S+
(#2) Growth in feed lots size, density, etc. from the 1971 level. 5 - S+

Action: (#1) Establishment of strict state controls on sewage systems, lot sizes, set-back from lake, etc. N - Se
(#2) Establishment of incentives to capture and treat wastes. N

PROBLEM: POLLUTION AND FILLING OF ESTUARINE AREAS OF BOTH COASTS FROM URBAN COASTLINE DEVELOPMENTS.

Event: (#2) Major construction of new towns in inland areas with federal support. 10 - M-

PROBLEM: TOXIC MATERIALS (E.G., CADMIUM) IN MANY WATER SUPPLIES.

Event: (#2) Contamination of some water supplies in large cities along with public release of data on such occurrences. 10 - NC

Action: (#1) Development of continuous and sophisticated monitoring technology. N

PROBLEM: DIVERSION OF MAJOR STREAM FLOW FROM HUMID TO ARID REGIONS.

Event: (#2) Development of shale oil deposits. 10 - M+

PROBLEM: LOSS OF WETLANDS FROM FILLING OPERATIONS OF DEVELOPERS.

Action: (#1) Strong federal and state legislation to protect wetlands. N

PROBLEM: REDUCTION IN ACCESS TO WILD AND SCENIC RIVERS FOR FISHING AND SOLITARY EXPERIENCES.

Event: (#2) Americans spend at least 6.3% of time on vacation. 10 - S+
(#3) Doubling, from the 1971 level, of the use of off-road vehicles (snowmobiles, dunebuggies, etc.) and construction of more and better roads into remote areas. 10 - S+

Action: (#2) Strong state and federal zoning of wilderness areas for wilderness uses. N
(#3) State licensing and regulation of the use of off-road vehicles. N - Se

PROBLEM: LONG-DISTANCE TRANSFER OF WATER FROM MOUNTAIN AND OTHER REMOTE AREAS FOR URBAN DEVELOPMENT.

Event: (#1) Sewage treatment technology permits recycling of waste water for drinking. 10 - M-
(#2) A chemical sewage treatment system which requires comparatively small volumes of water developed for individual homes. 10 - M-
(#3) Major new towns are located in the Southwest. 10 - M+

Action: (#1) Federal support for development, implementation, and use of advanced water treatment technology. N
(#2) Water use charges by local communities which discourage water consumption. N

PROBLEM: GROUND WATER SALINIZATION IN HEAVILY IRRIGATED, ARID, AND SEMI-ARID BASINS.

Event: (#4) Water prices increase markedly from 1971 level. 10 - M-

PROBLEM: PUBLIC HEALTH PROBLEMS FROM RECYCLING AND REUSE OF WASTE EFFLUENTS.

Event: (#2) New technology makes possible the production of completely "pure" recycled water. 10 - S-

Action: (#1) Governmental support of R&D programs to identify and find ways of removing all potentially hazardous materials. N
(#3) Development of continuous and sophisticated monitoring technology. N

Thus, there were fifty-four "high response" events in Round Three. While the panel considered these events in the differing contexts of individual potential problems, it is instructive to examine the events separately for patterns of relationship.

Fifteen of the fifty-four events (27.7%) which the panel judged probable for the future were technological in nature. With only three exceptions, the panel's median estimate for the occurrence of these events was ten years. With only four exceptions, these "high confidence" events were judged by the panel likely to have negative, or ameliorative, impacts upon their respective water resources problems. It appears that a good portion of the panel's hopes for the near-term future hinge upon the development of appropriate technology.

An almost equivalent proportion of the events (sixteen of fifty-four or 30%) were socio-economic or social in nature. The median estimate for the occurrence of these events ranged from five years (three events) to ten years (nine events) and even twenty years (four events). With six

exceptions (including four events judged to have no impact on their problems), the panel thought these events would have the effect of worsening water resource problems. Thus, it seemed that the panel's expectations about human behavior were pessimistic in terms of the impact of that behavior upon American water resources. It is striking that none of the events rated by panelists during Round Three (including, of course, both the original events presented to panelists in Round Two and the new events suggested by panelists during Round Two) were suggestive of awareness and restraint in human behavior and consumption patterns. Panelists were aware of the apparent need to alter human behavior, as a number of the suggested actions indicate, but they were not disposed to suggest specific events such as the purposive development of resource-conserving life styles.

A third category of "high response" events had to do with water depletion or scarcity. Eight of the fifty-four events (14.8%) were of this sort, and all but one of these were judged to contribute to their respective problems. All except one were estimated by the panel to occur within ten years.

Four events (7.4% of fifty-four) had to do with growth and its consequences, and all four were judged by the panel to contribute to water resource problems within the next two to ten years. Another four events (7.4%) were statements of government action. The panel's median estimate of likelihood for all four events was five years, but the panel saw no impact or could reach no consensus about the impact of three of the four. Three events (5.5% of fifty four) were descriptions of major disasters, and they all were judged to have positive impacts upon water resource problems during the next ten to twenty years. Miscellaneous events accounted for 7.4%.

Similarly, there were interesting groupings of the one hundred forty three different "high response" suggested actions in Round Three.

The largest grouping of these (49 or 34.2%) had to do with implied or express governmental control at some level. Most had to do simply with new laws and regulations (including taxation), particularly at the state, federal and even international levels. It was more common for these suggested actions via government to be phrased in punitive or delimiting terms than in terms of altered incentives. One gains the sense from reading these actions that the panelists endorse a much stronger central control over the actions of humans and their institutionalized ways of doing things.

Another large group of suggested actions (37 or 25.9%) were prescriptions for research and development. These were quite varied in nature, and ranged from the very specific to rather general proposals. As was the case with "high response" events, it is clear that the panel placed much reliance upon salvation by technology.

A third grouping of suggested actions (21 or 14.6%) were items recommending increased public education and participation. The education items included suggestions for public school environmental education programs, educational TV programs on water resources, programs encouraging the use of low energy-consuming devices, heightened publicity for firms seeking to avoid U.S. pollution regulations, and the creation of model low energy consumption communities (to demonstrate that alternative life styles with less energy consumption per capita are possible). Those items recommending enhanced public participation included increasing the public role in water resources planning and the provision of technical advice to individuals and communities about the appropriateness of alternative methods of development. Reading of the items in this group gives one the sense that panelists felt there were some potential benefits to be gained from increasing public involvement and consequent influence.

Another category (16 actions, or 11.2%) was planning, goal setting and policy formulation. These items describe national goals, mechanisms for implementing various sorts of planning, and policy determination methods judged appropriate for water resources.

There were also suggested actions which applied rather specifically to those professional and governmental personnel having water resources responsibilities (12 items or 8.4%). These items ranged from improved education for professionals to establishment of liaison between public officials and university research groups to action to eliminate graft and corruption in government.

Miscellaneous items numbered eight or 5.6%. These included some suggested actions which would have major socio-economic impacts, such as increased utilization of rail systems, major programs to rebuild cities and improve the urban environment, and redistribution of the work week to a seven-day basis to even out recreation use of areas.

Two other general observations about these "high response" suggested actions must be made. First, the sense of urgency in the panel's

judgments about these actions is clear. In all but seventeen of the one hundred forty three suggested actions (88.1%), the panelists thought implementation should occur "now". For the seventeen items (11.9%), it was common (14 items) for the panel to suggest a five-year objective for implementation. Second, there were few suggested items (19 or 13.3%) for which a significant proportion of panelists foresaw a conflict with the value configuration for the future derived in Round One. The most common conflict (14 items) was with self-oriented values.

Results: Round Three Panel Rankings of Water Resource Problem Sets

During the third round of the Delphi inquiry, panelists were given eleven sets of potential problems to rank in order of importance. These eleven sets were derived from problem statements submitted by the panelists in Round Two. The problem statements were clustered on the basis of similarity of general problem area by three judges. The eleven sets thus derived were not named, however, and in their deliberation, panelists were asked to name each set of problems. Each panelist also was provided the opportunity to rearrange problems among sets before making judgments about the problems.

The primary purpose of this exercise was to better identify general water resource problem areas and to assess their importance. Panelists were given one problem set as a standard and asked to rank all other sets in relation to this problem category. The procedure enabled the rankings to be made on a ratio scale instead of being limited to categories of importance.

The technique used to analyze the rankings made by the panelists is adapted by Sellin and Wolfgang.[3] The procedure is essentially as follows:

Each panelist's rankings were converted to natural logarithms and a mean overall panel logarithm score was calculated for each problem set. The logarithm scores then were standardized for each panelist and the overall mean of these standardized logarithm scores was obtained for each problem set. In addition, a standard deviation for each problem set was calculated to derive a measure of uncertainty in the rankings. The mean logarithm scores were correlated with the mean standardized scores by means of linear regression and a final absolute score calculated from this regression line.

As a result of the analysis, rankings of the problem sets were computed and are shown in the following table. The names of the problem sets were developed from a content analysis of the names submitted by panelists.

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[3] Sellin, Thorsten, and Marvin E. Wolfgang. The Measurement of Delinquency. John Wiley and Sons, New York, 1964. p. 274 ff.

PANEL RANKINGS OF PROBLEM SETS

Problem Name	Score			Standard Deviation of Standardized Scores
	Final	Absolute	Standardized	
Man-made Water Quality Problems		584	.906	.761
Water Supply Management		452	.677	.699
Industrial/Social Water Quality Responsibility		320	.368	.758
Energy Requirements for Water Resources		270	.218	.538
Social and Institutional Restraints		262	.189	.735
Water Resources Planning and Management		253	.159	.765
Social and Institutional Conflict		178	-.157	.954
Leisure/Recreation Water Use		157	-.265	.752
Destruction of Wetlands		120	-.506	.882
Flood Control		100	-.670	.700
Water as a Weapon		73	-.952	1.466

RELATIVE IMPORTANCE OF WATER RESOURCE PROBLEM AREAS DERIVED FROM DELPHI ROUND THREE

Problem Set Description	Relative Importance
Man-Made Water Quality Problems	XXXX

Methodology

As previously noted, the Delphi inquiry consisted of three separate rounds. Round One focussed specifically upon American values. Its purpose was to ascertain the value context within which panelists believed water resources problems and events would occur during the next thirty years. A register of American values offered by Nicholas Rescher was used for this purpose, and it appears in the Appendix.[4] The register contains seventy-two value items classified according to those which are self-oriented, group-oriented, society-oriented, nation-oriented, mankind-oriented, and environment-oriented. Rescher explains the rationale for the inventory as follows:

> We deal here with overtly espoused and publicly appealed to values to the exclusion of (1) unconscious motives (e.g., conformism, culture insecurity vis a vis Europeans) and (2) traits of national character (e.g., love of novelty). The factors included in the register are such that explicit or overt appeal to them can well be expected from publicly recognized spokesmen for values: newspaper editorialists, graduation exercise speakers, religio-moral sermonizers, and political orators. Such values can be extracted by 'content analysis' of the pronunciamentos of such sources. The values now at issue are those generally acknowledged and widely diffused throughout the society and not those specific to some group (physicians, Catholics, Chinese-Americans, Westerners). Moreover they are all socially general values in that those who espouse them do so as to value them not only personally (for themselves) and societally (for people in general). In short, we are concerned to list genuine values adherence and dedication to which is at this writing widely diffused throughout virtually all sectors of American society. The scheme of classification turns on the issue of the setting at issue in the maintenance of the value (oneself, one's group, the society, the nation, all of mankind, the environment.)[5]

The instructions for Round One began with a discussion of the purpose of the investigation and a general explanation of the Delphi method. Then, panelists were asked to consider each of the values in the inventory as they thought it would be held by American society as a whole during the next thirty years and to rate it as "probably less important than today", "probably about the same importance as today", or "probably more important than today". Reasons for the ratings were requested, and panelists were encouraged to add those values which they thought were needed to round out

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[4] See Nicholas Rescher, "A Tentative Register of American Values" in Baier, Kurt and Nicholas Rescher, Values and the Future, New York, 1969. pp. 92-95.

[5] Ibid., p. 92.

the list. The final two pages of the Round One inquiry asked panelists to indicate ways in which they could contribute to subsequent rounds and to provide some personal information for later use. The Round One inquiry form is contained in the Appendix.

As noted previously, 100 of the 124 who had indicated their willingness to participate returned usable Round One inquiries. Some panelists did not provide any explanations for their "less important" and "more important" ratings, as was requested in the instructions. Occasionally, a panelist would omit responses for an entire page, suggesting that two pages of the inquiry may have been turned at once. Comments and explanations sometimes were made about an entire category of values, although the inquiry was structured to obtain comments for each value item. In general, however, the completeness of the questionnaires and the high response rate suggested that panelists had no great difficulty in performing their assignments. This does not mean that there were no difficulties with individual items. Analysis of write-in comments and notes attached to the inquiry yielded seventy-one comments from thirty-five persons directed to the inquiry in general, to specific items in the inquiry or to reasons for non-participation in Round One. These are contained verbatim in the Appendix. They may be compared to a summary of the value items receiving a "no answer" response of 5% or more. That summary also is included in the Appendix.

Questions were raised by at least one person (participant or non-participant) for thirty-four of the seventy-two value items. There were sixteen value items for which five percent or more of the one hundred Round One panelists provided no answer. For the most part, these questions about individual items had to do with a perceived need for more clarity in defining the particular value item and with the perception that words clustered together to form a value item were different or represented different shades of meaning. A few persons (principally non-respondents) had other difficulties with the inventory. Some noted that the approach used ignored the contextual setting; one person felt that the dichotomy between personal values and group values was unacceptable; another found the task with all its uncertainties simply too "mind-boggling".

It is probable that the inventory could be improved. Certainly, the high proportion of Round One panelists (19%) who did not answer the item "novelty" among the environment-oriented values indicates that this item

was unclear. But for many other items the source of unclarity seems to stem from the basic method used to compile the inventory. Content analysis of public pronouncements having to do with American values from a wide range of sources is apt to produce words and phrases lacking the precision and clarity which would be optimal. On the other hand, construction of a "tight" inventory drawn from a single or more limited source might well omit items said by important participants in the society to be American values. In any case, the responses obtained in this exercise would appear to be quite useful in obtaining further refinement of the inventory.

Finally, panelists were asked during Round One to write in important values which they felt should be added to the inventory. A summary of these suggestions appears in the Appendix. The largest number of suggestions was made for the category "Environment-Oriented Values". These suggestions were consolidated into three new items for the environment category and were submitted to the panelists during Round Two together with those value items from the original list for which there was no Round One consensus. The results of that Round Two iteration appear in the Appendix.

Round Two

Just prior to the initiation of the second inquiry, all Round One participants were sent a report on the results of the first inquiry. The distribution of Round One participants by state and by type of respondent were reported as well as the number of respondents indicating expertise in each of several categories related to water resources and their future. Then, a special table was presented indicating the score, index and interpretation for the panel's Round One responses to the value inventory. This was followed by a brief verbal summary of these results.

Also included in the report was an appendix, containing (1) the number of responses in each choice category for each value item, (2) a summary of write-in comments of respondents, explaining their choices, and (3) a listing of the additional values suggested by the panel. With the exception of the write-in comments (which are too voluminous to include), these materials appear as part of the Appendix to the present report.

A final item in the report was a computer print-out specially made for each panelist, reporting the choices he had made on Round One. Using this print-out, the panelist could compare his responses to the group summary and he could check his responses as they had been keypunched for accuracy.

Panelists were not asked to evaluate this use of the computer in the process, and very little evaluation was offered. Exceptions were two commentaries submitted voluntarily by panelists, the first of which dealt with the computer as a part of the total methodology of Round One:

> A possible improvement to this 'wish list' might be to allow each respondent to put probabilistic estimates for more, less, or the same. It would be a more spohisticated guessing game than you have now.
>
> I think this portion of the Delphi was useless. Getting a lot of people to guess about something they no (sic) little about 28 years hence doesn't produce 'knowledge'. It more likely reflects the optimism/pessimism or mood of the respondent.
>
> Putting it through the computer may give the results the mystique of 'research' but at least I'll be able to realistically evaluate the quality of much Delphi research in the future. (044)

On the other hand, a second panelist, one who did find a coding error, wrote:

> I was most pleased with the way in which you have presented the results of the first round...The way in which you have presented data to participants in the study provides a magnificent opportunity to check on coding errors...

The instructions to Round Two, which were next mailed to all Round One panelists, began with these words:

> We should like for you to consider the panel's estimates about future value configurations as one indication of the social environment in which water resource problem, events, decisions and actions will occur during the next thirty years. (In this connection, it may be helpful to consider that, when something is 'valued', it does not necessarily mean that those who value it devote more attention, time or money to it, since it may simply be 'taken for granted'. However, the important point to remember is that persons may be more willing and prepared to do something on behalf of its maintenance <u>if such action becomes necessary</u>.) Bearing this in mind, when you consider future water resource problems, events and actions in this Second Round, try to incorporate into your reasoning and responses the influence of future value configuration in America.

There were three parts to Round Two. Part A presented to the panelists seven potential problems and related possible events and alternative actions which might concern America in the future use of its water resources. These seven problems were framed by the three organizations cooperating in the study, and they were pre-tested on various individuals, principally in the

Washington, D.C. area. It was necessary for respondents only to check their responses to these prepared items, but panelists were encouraged to add (by writing them in) events and actions which they thought were significant in relation to the specified problems. Sample forms were provided which illustrated the process. Then, panelists were asked to add (by writing them in) events and actions which they thought were significant in relation to the specified problems. Sample forms were provided which illustrated the process. Then, panelists were asked to add potential problems and related events and actions which they thought would be significant before the turn of the century. Step-by-step instructions for Part A were provided.[6]

Part B offered the panelists an opportunity to identify and explain the factors which they thought would operate to constrain ability to implement certain actions identified in Part A. The Part A format asked respondents to suggest actions which they believed would prevent or minimize the problem and it asked them to respond to the actions accompanying the prepared problems. For each such action, it was possible for the respondent to indicate that the action would be quite effective if implemented, but was likely to be implemented with great difficulty or perhaps was incapable of implementation. When panelists identified actions in this way, they were asked to respond to Part B for that action. Part B allowed the participants to identify the appropriate constraints and to provide written explanatory comments. There were also step-by-step instructions for Part B.

Part C presented the respondents with sixteen values from Round One about which there was no consensus, and asked for a re-consideration. One of the first round values ("Novelty" in the environment-oriented group) was deleted from re-consideration because it was clearly confusing to the panel, and three new environment-oriented values were added for initial consideration. These were composed from the suggestions offered by panelists during the first round.

The written comments of Round Two respondents on Part A indicate only scattered difficulty with such matters as the wording of problems, events, and actions; the manner in which problems were stated; and the choice of the seven problems for consideration by the entire panel.[7] Even so, these comments point up the difficulty of phrasing questions for a panel of experts coming from a variety of substantially different orientations. Some of the comments

[6] Round Two instructions are contained in the Appendix.

[7] These comments appear in the Appendix.

panelists provided on Part A were explanatory in nature and provided another input of expert counsel. Write-in comments on Parts B and C of Round Two (other than those specifically requested) were so few and of such a minor or redundant nature that they are not reported here.

The results of Round Two were submitted to the panelists together with instructions and forms for Round Three.

The report of results began with a distribution of Round Two panelists.[8] Then, it was pointed out that three basic types of analysis had been performed to deal with Round Two results and to prepare for Round Three. These were:

(1) Analysis of the judgments about potential problems, related events and suggested actions which were presented to the panel in Round Two;
(2) Screening and analysis of new problems, events and actions offered by Round Two respondents; and
(3) Analysis of the estimates about likely future value changes for those values on which the panel did not achieve Round One consensus.

As a result of this analysis, the panel's ranking of the original seven problems was included in the report of results. Also included was the panel's estimate of when each of the seven problems will become a national issue, and the panel's judgment about when action should be taken to preclude or minimize these problems.[9] Next, the report contained the panel assessment of how the occurrence of most of the events would affect the development of the problems. (For a few of the events, no consensus was achieved, forcing a Round Three re-assessment.) The criteria for determining consensus about problems, events and actions were explained in the report of results, and it was noted that sixteen of the original twenty-nine events were judged to be of significant or moderate impact. The report pointed out that there was no consensus on only six of the original events, and that these were to be re-considered in Round Three. Next, it noted that the remaining events, which had been judged to be of insignificant or no impact, were to be dropped from further consideration by the panel.

The report explained that actions were grouped into categories based upon the judgments about their effectiveness in preventing or minimizing the problem. The categories and their criteria were explained in the report, and

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[8] The report of results appears in the Appendix.

[9] This information appears in the results section of this report, rather than in the Appendix.

it was noted that eighteen of the twenty-one original actions were judged to be highly or moderately effective and only one was to be included for reconsideration because of no consensus. These impact and effectiveness results for Round Two were not detailed in the report; rather, they were shown in the first few pages of the Round Three inquiry forms, which were enclosed with the report.

An appendix to the report provided the panel with data about the barriers to implementation of actions (as perceived by the Round Two panel), and it also included comments from the panelists.[10] A final "values appendix" provided results of the iteration of those values for which no consensus was obtained during Round One.[11]

Round Three

As noted previously, the report of Round Two results accompanied the forms for Round Three. The analysis of Round Two results and the preparation of Round Three forms was, by all odds, the most difficult and time-consuming task the cooperating organizations faced throughout the Delphi. The abundance of material provided by panelists during Round Two was difficult to organize. More than fifty suggestions were obtained for new problems, and panelists submitted more than 110 new events, of which about forty were for the original problems with the remainder associated with the new problem submissions. More than 250 new actions were obtained with about 160 of these related to the original list of problems. In some cases, problems offered by panelists seemed to be more nearly events and actions than problems, and some reorganization of that material was performed in the preparation of Round Three forms. The new problems, events, and actions were included in the Round Three forms for assessment by the entire panel, and they were marked with the code number of the panelist who submitted them, so that each panelist could recognize his own contribution.

The presentation of this material to panelists required lengthy and complex forms.[12] There were two parts to Round Three. Part One presented the material from Round One and Round Two on problems, events, actions, and values, and it required only the placing of check-marks in columns. For each

[10] Summary information appears in the results section of this report, while panelists' written comments are in the Appendix.
[11] The "values appendix" is included in the Appendix to this report.
[12] These are included in the Appendix.

potential problem, panelists were asked to estimate when that problem will be a national issue, using the definition of "national issue" from Round Two.[13] The median and interquartile range of estimates from Round Two were displayed on the forms and panelists were asked to reconsider these estimates and to provide estimates for the first time on all new problems. The Part One forms next required panelists to consider the possible events. For each group of events, the first ones were those which were judged by the panel during Round Two to be of at least moderate impact; the next were the events (if any) where consensus about impact was not obtained during Round Two; last were the events which were offered by panelists during Round Two. For all events listed, the panelists were asked to estimate the time by which the event will be quite likely, using a probability of occurrence of at least 75% for this estimate. For those Round Two events on which the panel could reach no consensus and for all new events suggested by the panelists, the Round Three respondents were asked to estimate the impact the event, if it occurs, would have on the problem. Panelists did not have to re-consider those events about which there was second round consensus.

Then, the Part One forms requested panelists to consider suggested actions from Round Two. First, there were actions which the Round Two panel judged to be at least moderately effective; these were followed by those actions about which the panel could reach no consensus; finally, there were new actions suggested by the panelists during Round Two. For all actions, panelists were requested to indicate when they thought the action should be implemented. Finally, for all actions listed, the panelists were asked to indicate those value categories containing the likely future values which would conflict with the action. A value appendix was enclosed, containing Round One consensus about probable future values as well as the results of the Round Two iteration of those values for which there was no consensus on Round One. It should be noted here that the use of value categories, rather than individual value items (of which there were by Round Three seventy-four) was judged to be necessary in order to keep the magnitude of the task within manageable limits.

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[13] There were eight instead of seven original problems in Round Three, since the problem dealing with reduction in the availability of beaches and shorelines was split into two problems as a result of comments from Round Two panelists. The problem dealing with public apathy toward water resources decisions of the community was altered to delete population mobility as a contributing factor, again as a result of panelists' comments.

Part Two of Round Three was concerned with the relative importance and labeling of eleven problem sets made up of groupings of problems from the first part. They were identified on 5 X 8 cards as "Problem Set A" through "Problem Set K". Panelists were asked to read the problems as they were grouped on the cards. It was suggested that it might be helpful to array the cards on a table or desk in order to get a sense of the different categories of problems. Respondents were instructed that, if they thought a problem (or problems) should not be included in a particular set, they should indicate which set is more appropriate by writing the letter of the appropriate set in a box provided on the card. Next, panelists were asked to estimate, for each problem, the extent to which it would contribute to its problem set providing that it materializes. Then, they were asked to think of an appropriate label to assign to each set of problems; a suggested list of problem set titles was provided, but panelists were encouraged to devise their own labels if it seemed more appropriate. Finally, panelists were asked to estimate the seriousness of each problem set. The instructions for this exercise were as follows:

> Now you are asked to estimate the seriousness of each problem set. We have arbitrarily assigned a seriousness value of 100 to Problem Set H. Use this problem set as a standard. Every other problem set should be evaluated in relation to this standard value. For example, if a particular problem set seems ten times as serious as Problem Set H, write in a value of 1000. If a particular problem set seems half as serious as the standard, write in a value of 50. If a particular problem set seems only a twentieth as serious as the standard, write in a value of 5. You may use any whole or fractional numbers that are greater than zero, no matter how large or small they are just so long as they represent to you how serious the problem set is when compared to the standard Problem Set H with a value of 100.

Round Three panelists made numerous written comments on the inquiry forms, even though only check-marks were necessary.[14] Several types of panelist observations were apparent:

1. Comments explaining or qualifying specific answers given by the panelist. (E.g., "Assume this means projects to greatly increase standard of living." "I've marked the two -1's because such incidents would presumably bring pressure to bear on decision-makers.")

2. Questions and comments indicating desire for clarification of problems, events, and actions. (E.g., "How many?" "What does this mean?")

[14] These comments appear in the Appendix to this report.

3. Suggestion of new actions. (E.g., "Provide U.S. assistance with foreign population control programs.")

4. Criticism of problems, events, and actions as being incorrectly stated, too vague or biased. (E.g., "Ambiguous." "Not clear." "Loaded!")

5. Criticism of choice of problems, events or actions as being not really significant in nature or as being inappropriate to the Delphi. (E.g., "This is no problem of major issue proportions." "This doesn't appear to me to be a potential problem.")

6. Instructive comments. (E.g., "River fishing is a completely negligible food source. All the world's fisheries (oceanic) produce only 1% of food supply." "This is not just a water resource management problem. Actions taken in the water resources area are likely to have small effects compared to those taken in other areas.")

7. Criticism of events and actions as being unrelated to problems. (E.g., "Can't see relationship to problem.")

It is clear that Round Three represented a prodigious amount of work for the panelists and an immense amount of information to be interrelated by them. It was an extremely difficult inquiry to put together without severe editing; nevertheless, it was decided to submit Round Two information - especially the new contributions from panelists - as faithfully as possible in order to obtain reactions from all panelists to the newly-generated problems, events and actions, as the panelists conceived them. Because of the problems of inquiry length, item overlap, and item clarity, this procedure reduced the reliability and usefulness of the specific estimates made; on the other hand, it allowed some ot the real debate to take place which needed to go on between panelists from diverse backgrounds - and that debate certainly included such issues as problem relevance and the interrelationship between problems, events and actions. That this approach - with its requirement of responses to each individual panelist's inputs - discouraged some from continuing with the final Delphi round is certainly true, as the following testy letter from one panelist indicates:

> After considerable thought and with reluctance, I must decline to complete Round Three of the Delphi investigation of water resources.
>
> If I were to give proper consideration to the multiple judgments involved, it would take me a good two days; in other words, you are asking me to contribute approximately $300 of my time to Round Three.

> I do not have the time, nor do I believe I committed myself to a contribution of this magnitude when the project was described and my participation solicited.
>
> My reluctance to sign off is based on my opinion that, at least until Round Three, I was involved in a useful venture, directed by intelligent people. Round Three, with its motley mass of unedited individual-participant suggestions, many of which are ambiguous, unclear, or meaningless in the analytical context, has shaken my previous opinion.
>
> I wish you luck with your other participants.[15]

Clearly, this was not the best possible approach to Round Three. In retrospect, more editing and consolidation were undoubtedly possible (although this raises the necessity to consult with individual panelists, perhaps by telephone, in order to be certain that the intent of contributions is clear and that true duplication exists.) More time between rounds and perhaps more rounds would have enabled tighter questionnaire construction and the presentation of manageable tasks to panelists. But these were alternatives precluded by constraints of time and funding.

Another, and fundamental, difficulty probably would not have been alleviated by more time or simple editing. That is the matter of basically different epistemologies between panelists, perhaps most apparent between those with an ecological frame of reference and those with a frame of reference centered upon the satisfaction of human needs and desires through private enterprise, development, and the like. When panelists are deliberately chosen to represent different classes of experts deriving from different interests and frames of reference (as is the case here), it becomes extremely difficult to create "unbiased" problem, event and action statements. But debate between different classes of experts may be an important function in the consideration of the future, and it may not take place automatically in the usual settings when the issues revolve around such vital matters as water resources and where the issues are politicized. The Delphi, since it ensures anonymity, can be very useful in these situations, but it would seem that its usefulness rests upon its utilization in particular ways. Perhaps the major utility of a Delphi exercise utilizing a panel assembled to represent diverse expertise lies not so much in the particular estimates of the future which are made as with the delineation of the boundaries within which future decisions, actions,

[15] Some solace can be derived from the possibility that the panelist listed these reasons for not continuing in the Delphi in order of descending importance.

conflicts and developments likely will take place.

The Round Three use of the six value categories (Self, Group, Society, Nation, Mankind, Environment) rather than all seventy-odd value items in the Inventory caused some difficulty for panelists. (Of course, the requirement that respondents identify potential value conflicts with each suggested action using an inventory of values numbering more than seventy would have made a monumental task even more staggering.) Several panelists expressed their inability to "think" in such categorical terms, and some noted that the inherent lack of specificity in the categories would lead to questionable results. Respondents were asked only to check value categories where they believed conflicts were apt to occur with actions, if implemented. Still, the frequency with which respondents identified such conflicts varied rather considerably from almost no indication of conflict (e.g., action items suggesting additional research) to substantial indication of conflict where half or more of the panel saw conflict in one or more of the value categories (e.g., suggestion of government effort to reduce economic or industrial growth, suggestion of power rationing, and suggestion of population control programs). On balance, the generally low rate of response in the value categories together with panelists' comments suggests more than a little difficulty in performing this task. Of course, whatever skills are important in assessing the impact of actions upon values undoubtedly do not find many opportunities for practice and development; such is the present state of our ability to think and operate in value-analysis terms.

SUMMARY AND CONCLUSIONS

1. A national inquiry about the future of American water resource utilization and development was conducted from January to October of 1972 by the Office for Applied Social Science and the Future (University of Minnesota), the Futures Group (Glastonbury, Connecticut), and the Institute for Water Resources (Alexandria, Virginia). Three rounds of questions were submitted to a diverse panel of experts, including general academics, water resources academics, general government representatives, water resources government representatives, commercial representatives, public and private interest group representatives and private citizens, and consultants. The Delphi technique, employing iteration with considerable opportunity for initiated inputs from the anonymous panel members, was chosen as the principal method.

2. When asked to estimate the direction of change in American values over the next thirty years (using a standard value inventory), the panel reached consensus on the initial round concerning approximately three-fourths of the value items. For about one-third of the values, increased emphasis was foreseen, while declining importance was seen for almost one-fifth. In the case of one-fourth of the values, the panel believed there would be no change in importance. In the panel's view, changes in self-oriented values will be rather mixed; there likely will be more stability than change in group-oriented values; there probably will be a positive shift in most society-oriented values; most nation-oriented values are apt to undergo erosion; mankind-oriented values for the most part will become more important; and the environment-oriented values (which the panel augmented) will become much more important.

3. During the second round of the inquiry, the panel was asked to rank-order seven prepared problems in terms of their relative significance. The problems ranked most important were those related to growth, affluence and life-style and those arising from the erosion of public confidence in officials and from conflicting jurisdictional demands from various governmental and non-governmental groups. These were problems viewed by the panelists as likely to become national

issues within the next five years, and the panel was convinced that action should be taken now at the national level.

4. During Round Two, the panel concluded that more than half of the prepared possible events associated with the seven problems would have significant or moderate impact upon their respective problems. Also, the panel judged that almost all (eighteen of twenty-one) of the prepared suggested actions associated with the problems would be highly or moderately effective in terms of eliminating the problem or preventing its development.

5. Panelists also identified barriers which would act as impediments to actions they considered potentially effective. Sixty percent of the "barriers to implementing actions" were classified by the panel as "institutional/political", while smaller proportions of the barriers were identified as "cost" (14%), "lack of criteria" (11%), "technological" (8%), and "others" (7%). Panelists provided extensive comments about the exact nature of these barriers.

6. During Round Two, panelists suggested more than 50 new problems, 110 new events, and more than 250 new actions to supplement the prepared materials originally submitted to them. After some consolidation and reorganization, these new materials were added to the original and submitted to the panel for reassessment during Round Three.

7. While there were methodological problems related to Round Three which might have been alleviated by additional time and funding, some useful results emerged. Eleven sets of problems, composed of those originally used and those submitted by panelists, were given to the panel for rank-ordering. Using a magnitude estimation procedure, panelists assessed the importance of these general water resources problem areas and helped to describe them by suggesting names for each problem set. The resulting data indicate two paramount problem areas: Man-Made Water Quality Problems and Water Supply Management. The panel judged that four other general problem areas were less critical, but nevertheless important: Industrial/Social Water Quality Responsibility, Energy Requirements for Water Resources, Social and Institutional Restraints, and Water Resources Planning and Management.

Of relatively minor importance in the panel's view were Social and Institutional Conflict, Leisure/Recreation Water Use, Destruction of Wetlands, Flood Control, and Water as a Weapon.

8. Examination of those Round Three events about which the panelists indicated confidence in making judgments revealed that a good portion of the panel's hopes for the near-term future hinge upon the development of appropriate technology. This analysis also suggests that the panel was pessimistic about human behavior in terms of its impact upon American water resources.

9. Analysis of the Round Three suggested actions about which the panelists indicated confidence in making judgments revealed some interesting patterns. A large group (34%) had to do with implied or express governmental control at some level, and that control was commonly suggested in punitive or delimiting terms rather than in terms of altered incentives. Another large group of these actions (26%) were prescriptions for research and development, and they underscore the panel's apparent hope for salvation by technology. A smaller proportion of suggested actions (14.6%) recommended increased public education and participation as an effective approach, and an even smaller proportion (11.2%) had to do with planning, goal setting, and policy formulation. Overwhelmingly, the panel thought that implementation of these actions should occur "now" and not later. In only a relatively few cases (13.3%) did the panel foresee a conflict between these suggested actions and the future value configuration derived in Round One.